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Subject: Study of Origin and Propagation of Disturbances in the Burning of Solid Propellants (SRI Project PRU-2770)
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April 1 - June 30, 1962

Admittance Measurements on Cold Samples by the Reflected Pulse Method

In Progress Report No. 13, we presented two admittance vs. frequency curves for a sample surface consisting of sandpaper cemented to an aluminum block. The two curves, obtained at pulse pressures of about .002 and .002 atm. respectively, showed satisfactory agreement for angular frequencies from 9000 to 22,000 sec^{-1}. We pointed out, however, that the admittance measured was not primarily due to absorption by the sample surface but rather to a small amount of leakage arising from the particular way in which the sample was mounted at the end of the pulse tube. During the current quarter, two types of samples were investigated. The first type (already referred to in Report No. 13) involved patterns of tetrahedral pyramids of several heights (up to .25 inches), milled into the end of aluminum cylinders. It soon became evident that these milled surfaces are unsuitable as standard samples because their (normalized) admittances are too small. The second type of sample consists of a cup partially filled with lead shot and mounted so as to form a continuous extension of the pulse tube. By varying the

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size of the shot and depth of loading, different admittances can be obtained. Some preliminary results are shown in Figs. 1 and 2. The pulse amplitudes used were .002 and .0008 atm., respectively. The discrepancy between the curves obtained at the two pressures, and the fact that the low-amplitude curve dips below zero, are quite likely due to a small amount of leakage in the mounting of the cup when the zero admittance (cup empty) measurements were made for the low-amplitude series. A new pulse tube and a new type of fitting for attaching the cup are now under construction and we hope that these will eliminate the leakage problem in the future.

A literature search is being made to find if there are any data on the acoustic properties of beds of spheres against which to compare ..r own measurements.

Burning Propellant Experiments

Very recently a previously unsuspected phenomenon has been identified in connection with the burning runs. Very large excursions of the oscilloscope trace, which had been believed to be due to electrical pick-up from the spark source, have turned out to be of acoustic origin. In Fig. 3 we see the incident and a number of reflected pulses from the spark source superimposed upon a sine wave of about 40 cycles sec^{-1}. The pulse amplitude is about .002 atm; the amplitude of the sine wave appears to be much larger but (taking into account the frequency response of the shielded microphone) may actually be lower than the pulse amplitude. In Fig. 4 we see a record (on a different time scale) of the same phenomenon with the spark source absent. Extending the length of the pulse tube from 8.5 ft to 12.5 ft changes the frequency of the sine wave to 25 cycles sec^{-1}. Occasionally, the sine wave is absent for several runs.

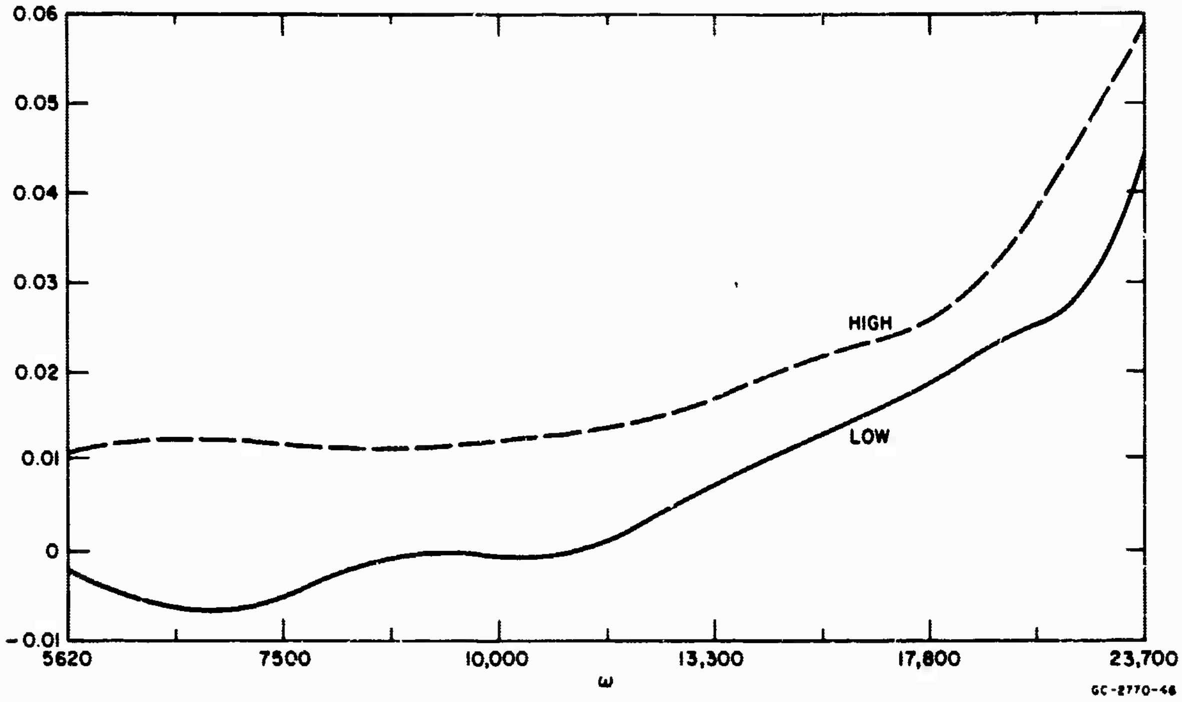

FIG. 1 AVERAGE VALUE (at two pressure levels) OF $Re(Y_{true}\rho_0 c_0)$ OF A SOLIDLY BACKED 8.5-mm COLUMN OF 1.2-mm-DIAMETER LEAD SHOT

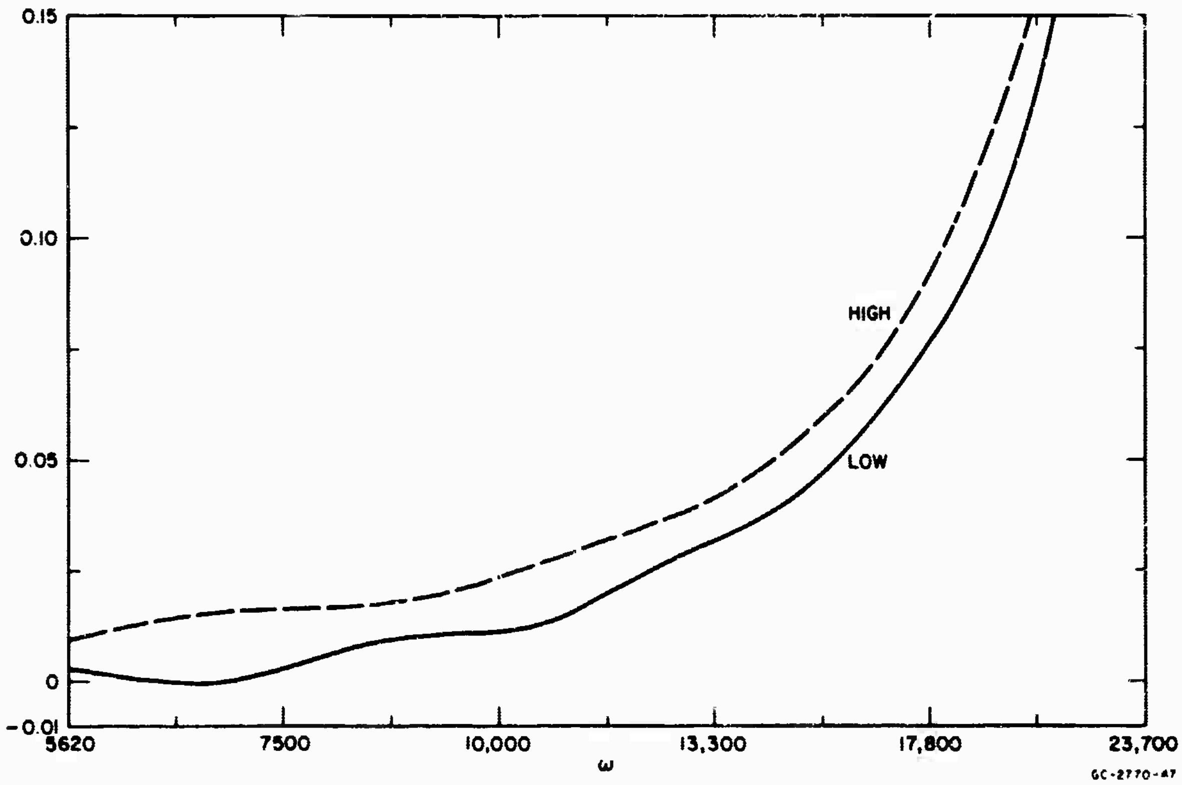

FIG. 2 AVERAGE VALUE (at two pressure levels) OF $Re(Y_{true}\rho_0 c_0)$ OF A SOLIDLY BACKED 13.1-mm COLUMN OF 1.2-mm-DIAMETER LEAD SHOT

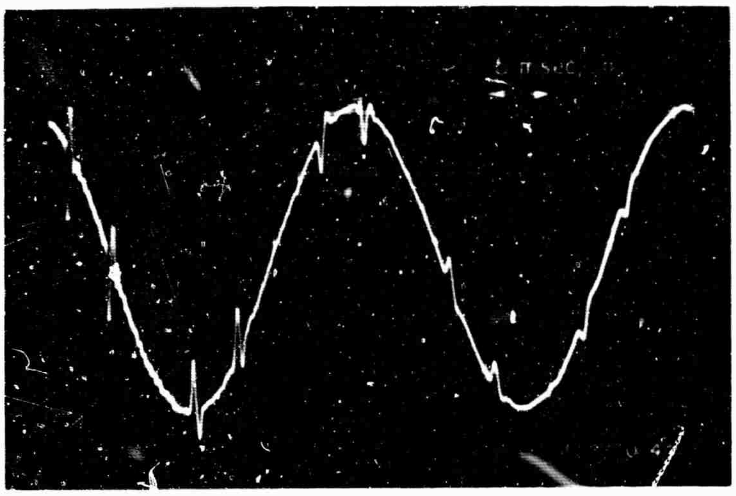

FIG. 3 PROPELLANT SAMPLE
B11 - BURNING RUN

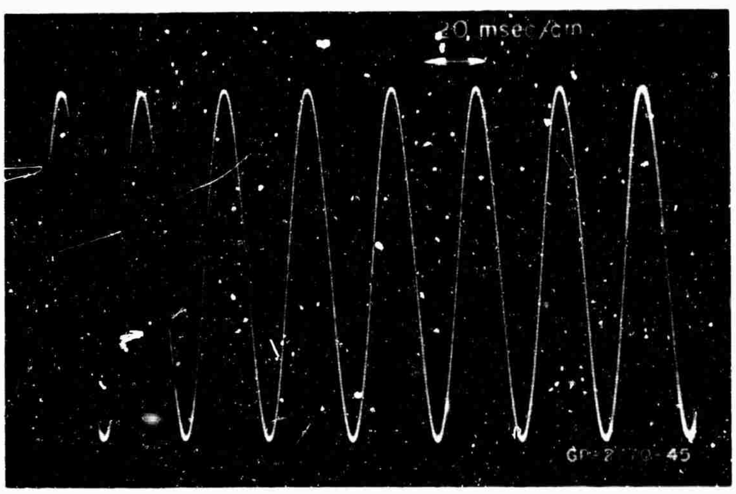

FIG. 4 PROPELLANT SAMPLE
B17 - BURNING RUN (No Spark)

Because of the relatively low amplitude of the sine wave, it is unlikely that we are observing a manifestation of low-frequency combustion instability although this possibility cannot be ruled out. While the sine wave could probably be eliminated from the pulse records by a suitable filter, we are concentrating our efforts at the moment on a series of experiments aimed at explaining and, if possible, suppressing this phenomenon; simultaneously, we are searching the literature for any helpful information on the subject.

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PRU-2770

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